« Proposition of a Real-Time MAC protocol for Wireless Sensor Networks »

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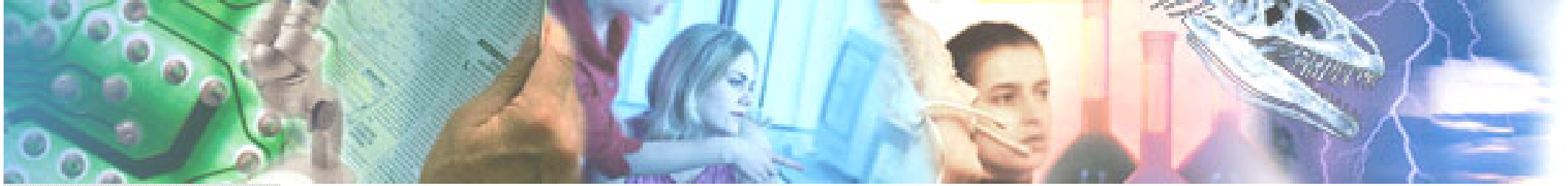
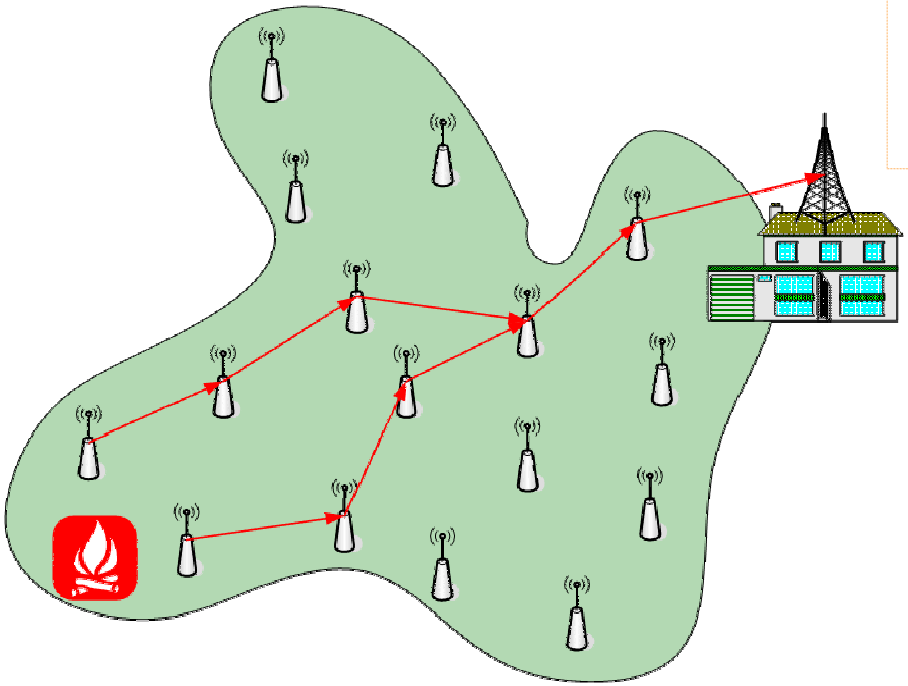


Wireless Sensor Networks

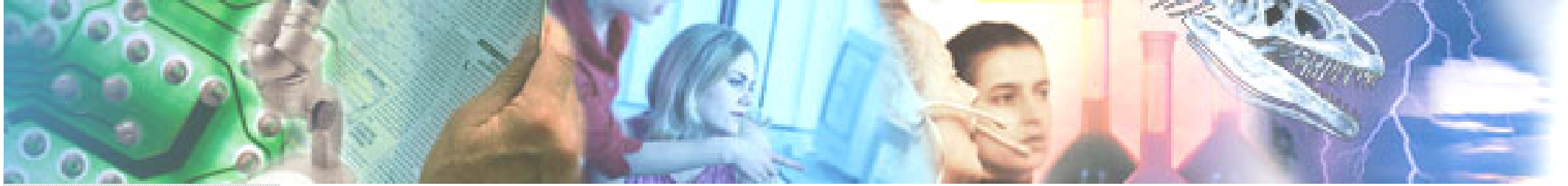
➲ Wide range of applications Military, surveillance, Health, smart homes …



Embedded systems
- computational power
- memory
- embedded energy

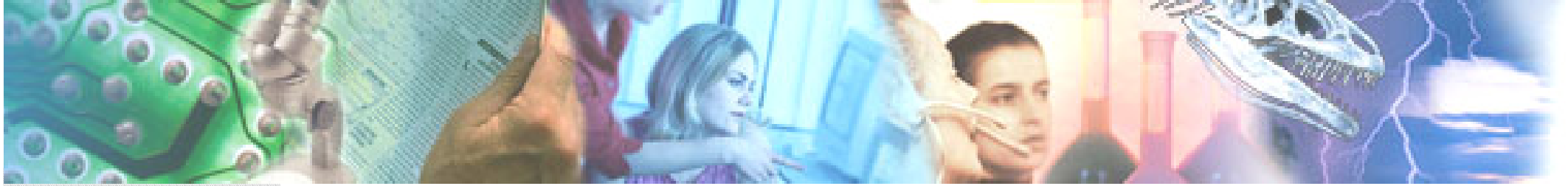
Ad-hoc Networks
- no fixed infrastructure
- changing topology
- multi-hop transmission

➲ **Real-Time Constraints** appear as “natural” *(deadline)*



Overview

1. **Related Work**
2. Proposed Protocol
3. Formal Validation
4. Conclusion and Future Works



Real-Time in WSN

Soft Real-Time

Loose applications, **miss ratio** accepted

➲ Flow differentiation at OSI layers 2 or 3

ex: RAP *(Lu, Blum, Abdelzaher, Stankovic, He, 2002)*
SPEED *(He, Stankovic, Lu, Abdelzaher, 2003)*

Hard Real-Time

Always reach destination before a **deadline**

Known, bounded and guaranteed
Execution/Transmission times : **Worst Case Times**

➲ Message scheduling

ex: I-EDF *(Caccamo, Zhang, Sha, Buttazzo, 2002)*

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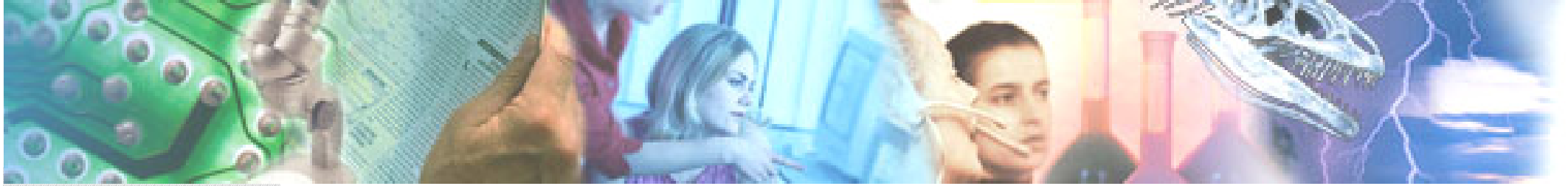
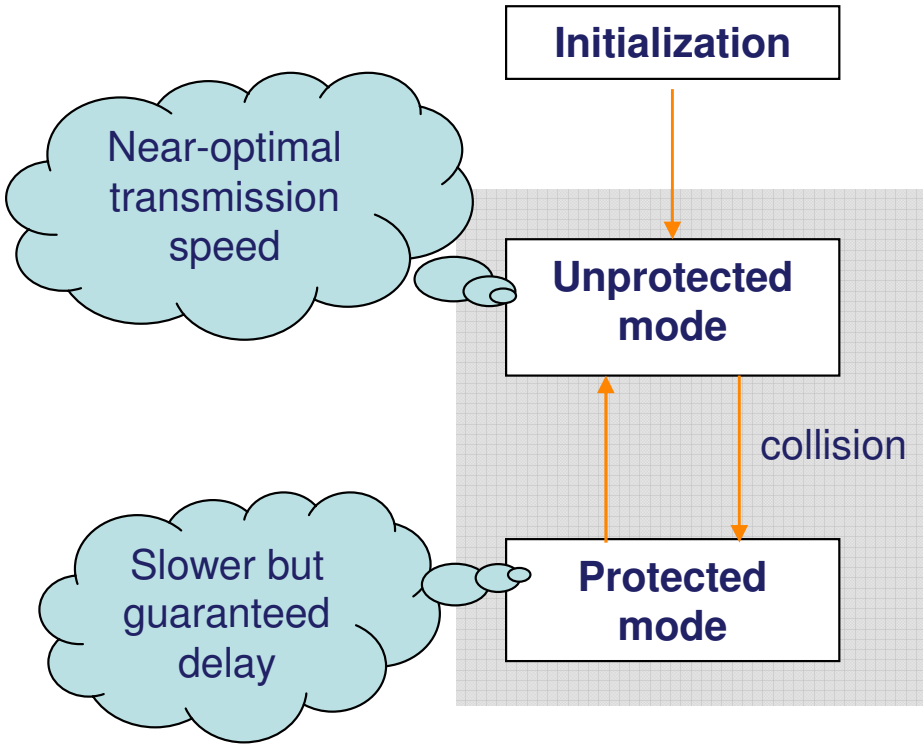


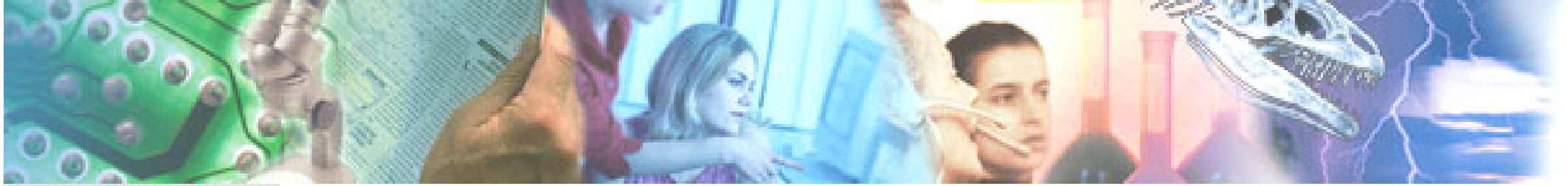
Overview

"Propose and validate a MAC protocol for WSN offering hard Real-Time guarantees"

No routing, **linear networks** as an application domain:

- highway car accident monitoring
- railway train tracking
- production chain surveillance





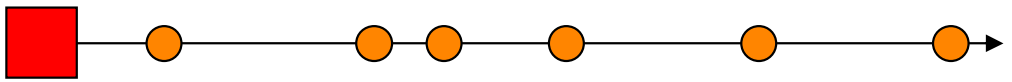
Hypothesis

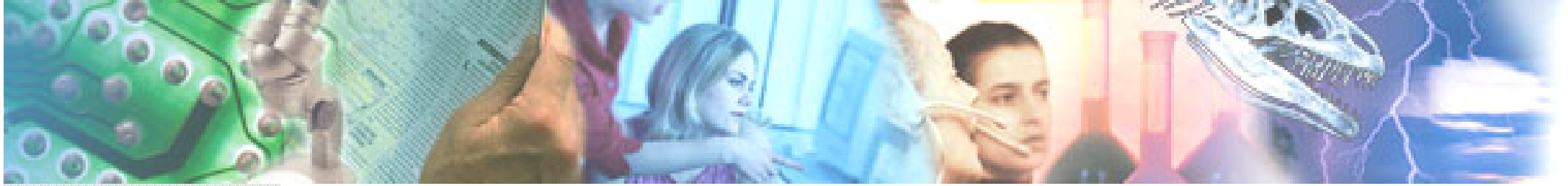
Node

- similar nodes
- one frequency, one power
- no GPS-like positioning/synchronization
- node knows its position

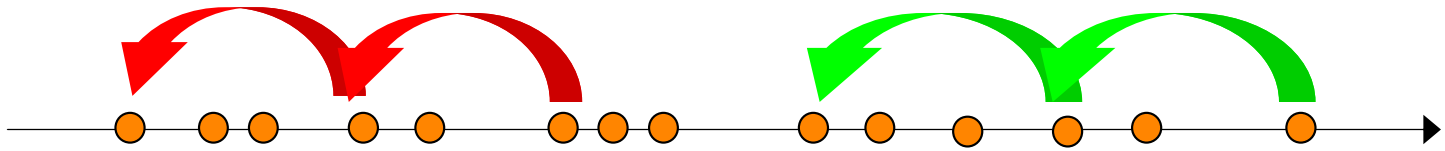
Radio link

- bidirectional
- no transmission errors
- Unit Disk Graph

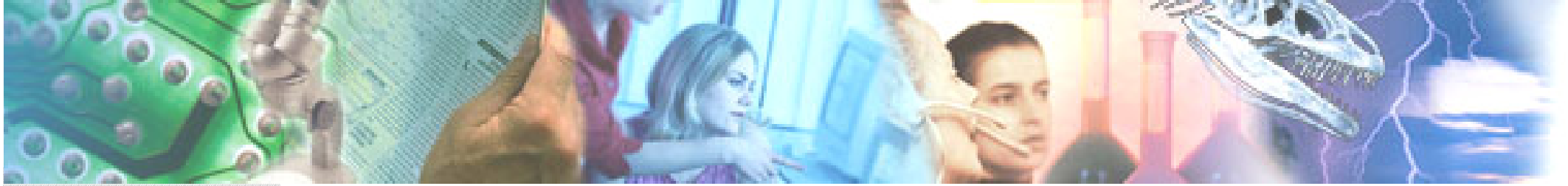




Unprotected Mode



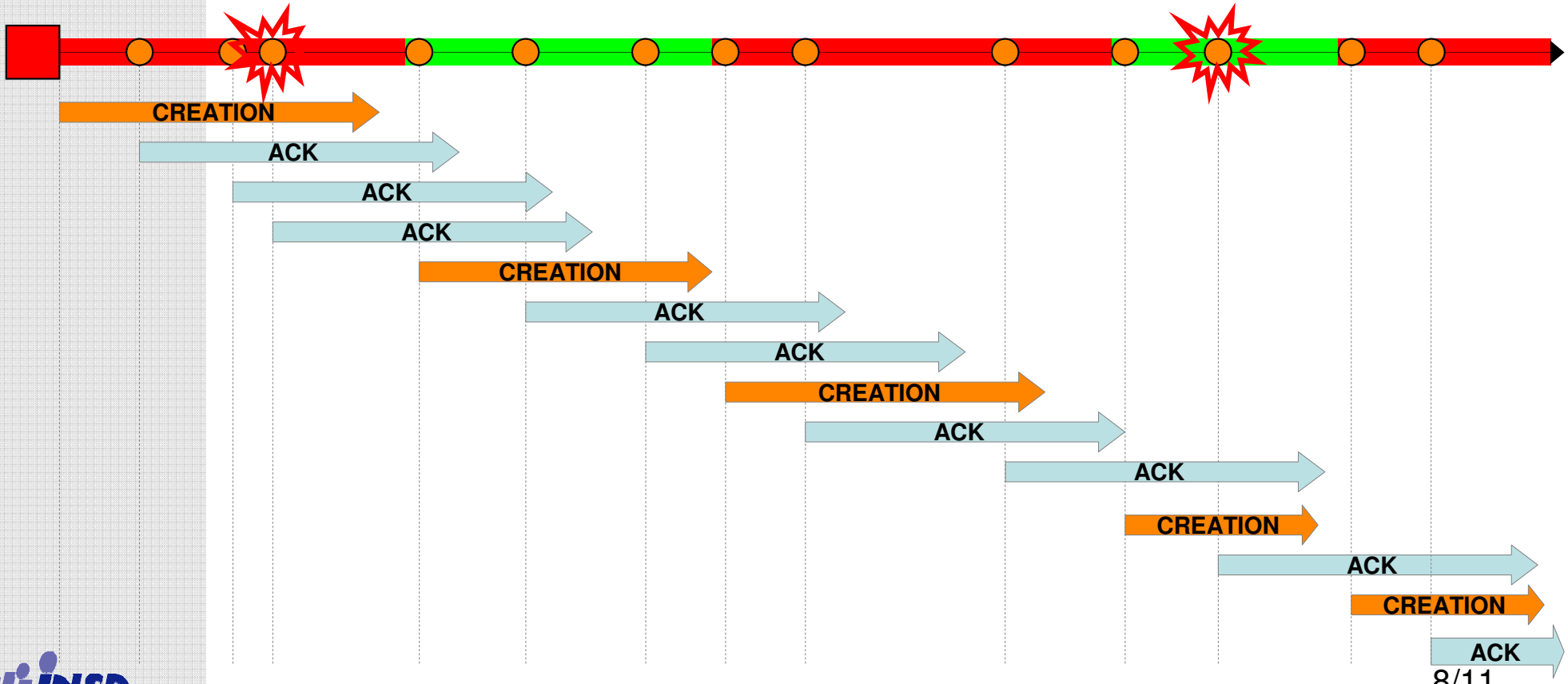
- as fast and far as possible
- relaying node election based on internal timers (the further from the sender, the less the node waits)
- collision prone…

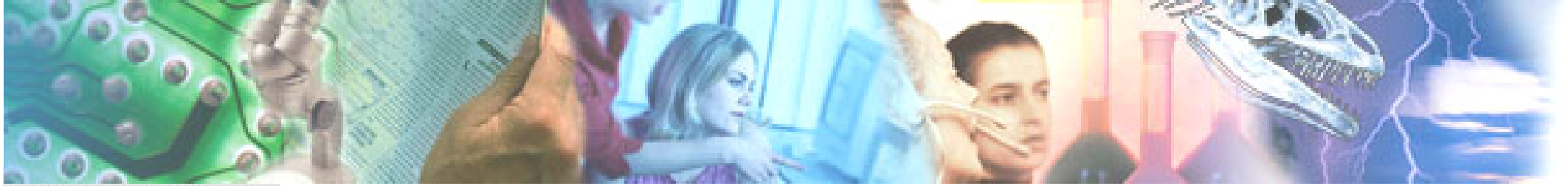


Protected Mode

Goal: Separate two emitting node by enough distance

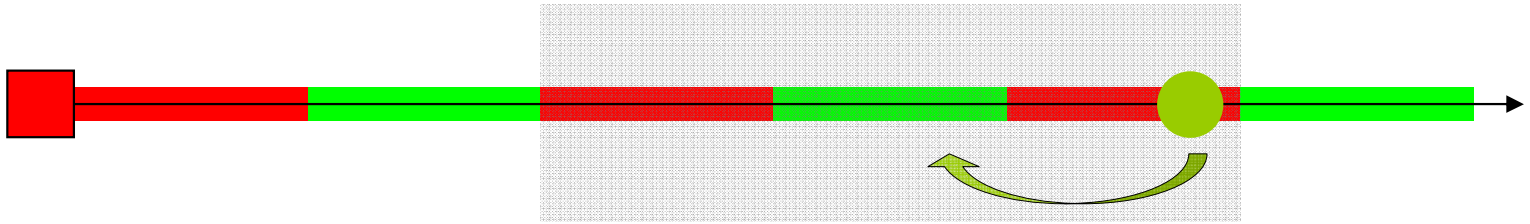
➲ Construct cells of length one transmission range



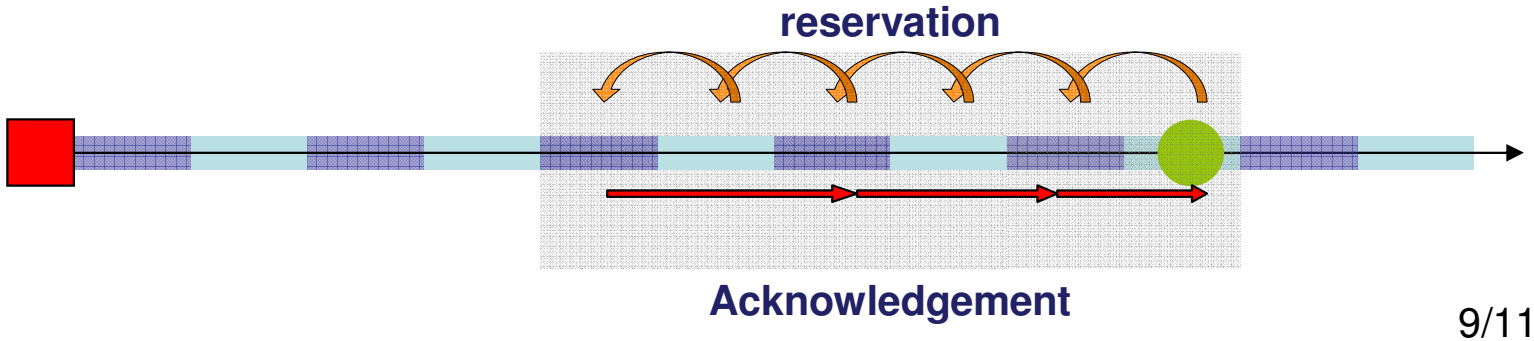


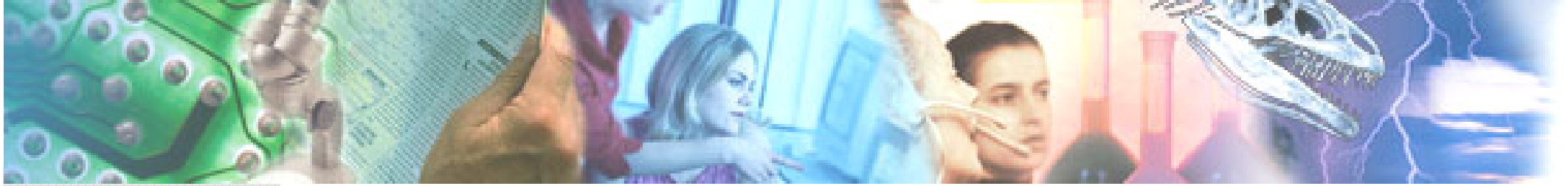
Protected Mode

Reservation, then sending



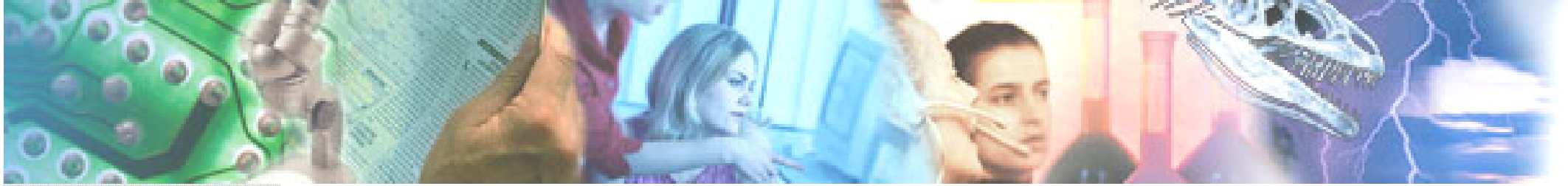
Reliability for signaling messages: **cells cut in half** and **synchronization**





Formal Validation

- **Behavior** and **Timeliness**
- **Worst Case** times determined analytically
- Formal validation using **UPPAAL** (model-checking, timed automata)



Conclusion and Future Work

Conclusion:

- Proposed a Hard Real-Time MAC protocol for WSN
- “Simple” sensors
- Formally Validated

Future Work:

- Extract protocol’s performances using simulation
- Compare protocol’s performances with other MAC protocols (*802.11*)
- Physical implementation on a test-bed
- Add fault tolerance mechanisms
- 2-D extension: Hard Real-Time routing layer

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